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ABSTRACT

This booklet integrates science, history, and environmental education to help students acquire a basic understanding of the importance of the Great Lakes located in the United States. The packet also contains a Great Lakes Basin resource map and a sand dune poster. These materials introduce students to a brief history of the lakes, the diversity of freshwater aquatic life, the complexity of the Great Lakes watershed, and environmental concerns. Appended are a listing of Great Lakes educator resources, field trip/educational opportunities, and educational tools for those teachers who may wish to pursue additional Great Lakes environmental educational opportunities. (KR)

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Great Lakes Education Booklet 1990-1991

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Michigan Department of Natural Resources
Office of the Great Lakes

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STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
P.O. BOX 30028
LANSING, MI 48909

DAVID F. HALES, Director

Welcome to the Great Lakes Education Program!

On April 16, 1990, we celebrated the 20th anniversary of Earth Day. For the day, the world paused and observed the progress we have made in protecting and cleaning up the environment and what still needs to be done. This observance provided an opportunity to reaffirm our commitment to protecting and preserving the Great Lakes as well as Michigan's other bountiful natural resources. And it reminded us of our obligation to learn and to teach.

Our wise stewardship of the Great Lakes is essential to our continued ability to use and enjoy them—now and in the future. We must encourage our students to achieve greater understanding of the Great Lakes ecosystem in order to manage them more wisely and protect their health. Recognizing the enormous educational needs associated with this stewardship, Governor James J. Blanchard has designated September 24-28, 1990 as Great Lakes Education Week.

This Great Lakes Education Program Booklet provides a blend of science, history, and environmental education to help young students acquire a basic understanding of the importance of the Great Lakes. The booklet includes six Great Lakes "fish cards", a Great Lakes Basin resource map, and a colorful sand dune poster. These visual aids and colorful teaching tools will enhance your students' enthusiasm for learning about the Great Lakes. These materials introduce your students to a brief history of the lakes, the diversity of freshwater aquatic life, and the complexity of the Great Lakes watershed.

This Great Lakes Education Week Booklet provides an excellent opportunity to bring the sights, sounds, and wonder of the Great Lakes Basin to classrooms across Michigan. I hope you will use it well and frequently, and I look forward to working with you to educate our future stewards about the crown jewels of our abundant water resources.

Sincerely,

David F. Hales, Director
Department of Natural Resources

R1026
8/88

RECYCLED PAPER

Great Lakes Education Booklet 1990-1991

Introduction

This booklet contains visual aids and hands on teaching tools that we encourage you to incorporate into your lesson plans during Michigan's first Great Lakes Education Week, September 24 - 28, 1990. They include:

- ***Six Great Lakes Fish Flash Cards*** - That can be duplicated for students to color and study, or make into a fish mobile, or used in a quiz contest
- ***A Michigan Coastal Dunes Poster*** - That contains a wealth of information on the types of coastal dunes, their geology, locations, vegetation, and animal inhabitants
- ***A Great Lakes Basin Resource Map*** - That contains information that may be incorporated into social science, geography, or earth science classes.

We have included a short scorecard on page 13 to test students on the Great Lakes information we have presented in this booklet.

At the end of this booklet you will find a listing of Great Lakes educator resources, field trip/educational opportunities and educational tools for those teachers who may wish to pursue additional Great Lakes environmental educational opportunities.

These teaching materials serve as a general introduction to annual Great Lakes educational packages to be released during the five-year Great Lakes Education Program. These lesson packages will cover such topics as:

- Fisheries and aquatic life
- Sand dunes and coastal wetlands
- Shipping and navigation
- Great Lakes history/geography
- Great Lakes water quality

The Greatest Freshwater Show On Earth!

Comprising 40 percent of the state's 96,791 square mile area, the Lakes hold 6 quadrillion gallons (that's 6,000,000,000,000,000!) of fresh water and form 3,288 miles of Michigan coastline. Only Alaska has more coastline. If all of the Great Lakes' water was spread evenly over the continental United States, our nation would be submerged below nine to 12 feet of water.

The combined shorelines of the five Great Lakes—Superior, Huron, Michigan, Erie, and Ontario—equal half the circumference of the earth. These giant freshwater reserves provide drinking water to 23.5 million people in two countries.

The vastness and unique qualities of these fresh waters make it critical to protect, yet profoundly challenging, to manage them. Being situated in the center of the largest source of freshwater available in the world creates a special responsibility for Michigan citizens to act as careful and willing stewards of their water resources. The goal of the Great Lakes Education Program, therefore, is to help teachers, students, and the public understand and appreciate the nature of our water resources so that they can properly manage and adequately protect them now and in the future.

Early Great Lakes History

The history of the Great Lakes begins with the retreat of the Wisconsin Glacier some 10,000 to 15,000 years ago. After great chisels of glacial ice sculpted the lake basins, melted glacial water accumulated in the scoured terrain. As young as the Great Lakes are in geologic time, the region also contains some of the oldest rock in North America, known as the Precambrian Shield. This bedrock dates back about three billion years.

The first inhabitants of the Great Lakes region probably arrived shortly after the last glacier receded about 10,000 years ago. These Native Americans crossed the land bridge that once connected the continents of North America and Asia in Alaska or traveled across the Pacific Ocean to South America. These native people included tribes of the Iroquois, Alumettes, Chippewas, Hurons, Ottawas, Senecas, Mohawks, Eries, and Ojibways. Lake Huron was named after the Huron tribe, and the city of Pontiac was named for a great Ottawa chief.

The War of 1812 was fought by Americans for the freedom to expand into and settle the Great Lakes region. The most important battle of the War was fought on Lake Erie after Oliver Hazard Perry blockaded the British at Amhertsberg (across from Bob-Lo Island). This American naval victory on the Great Lakes assured U.S. control of Michigan and the other Northwest Territories.

The French were the first European explorers and settlers in the Great Lakes Basin in the 1500s and 1600s. They constructed forts along the Great Lakes, including Fort Pontchartrain on the site of Detroit in 1701. The British actively settled the lower Great Lakes in the 1700s, and retained control of the region even after the end of the Revolutionary War.

Michigan's Native Americans

Meet The Great Lakes

Lake Superior

Lake Superior is the largest lake in the world in surface area. A lake of many names—Le Lac Superieur, Kitchigammi, Gitchee Gummee, Lac Trace and Grand Lac—it is 350 miles long and 160 miles wide. Its waters drop to a depth of 1335 feet. Its surface area spans 31,669 square miles.

Lake Superior is surrounded by Canada and the states of Michigan, Minnesota and Wisconsin. It is home to Isle Royle National Park and the National Lakeshores of the Apostle Islands and Pictured Rocks.

Superior is also a lake with a stormy reputation. Some 300 ships that have been lost in savage storms that swept across the lake lie in the depths of Whitefish Point. Elsewhere in Lake Superior lies the shipwreck of the legendary Edmund Fitzgerald.

Although it is the cleanest of the five Lakes, and lies within the least populated region, Lake Superior must still contend with pollution from human activities—from airborne contaminants to mining and papermill operations.

Lake Superior is connected to Lake Huron by the St. Marys River where the Soo Locks control the level and flow of water to permit safe passage by vessels. Lake Huron is 206 miles long and 183 miles wide, and reaches a depth of 748 feet. More than 30,000 islands are found in this sister lake of Lake Michigan, some of which are a part of Michigan's newest recreational adventure attraction—the Island Explorer Water Trail in Northern Lake Huron and the St. Marys River.

Lake Huron is the second largest Great Lake after Lake Superior, and prior to settlement was bordered by thick forests of white and red pine. National forests, scenic rivers, beaches, and state and Canadian parks are plentiful along the Lake, totalling about 400,000 acres.

As a result of the industrial and agricultural activity in the highly populated tri-city area of Saginaw, Bay City and Midland, the Saginaw Bay/River is identified as an Area of Concern (one of 42 throughout the Great Lakes) by the International Joint Commission. As a result, a Remedial Action Plan (RAP) has been developed to guide the process for cleaning up pollution in the area.

The RAP is serving as a vehicle for innovative approaches to cleaning up the Saginaw Bay and River. Several state and federal agencies with various universities are working together to attack the area's pollution problems.

Lake Michigan

Lake Michigan is the only Great Lake completely within the borders of the United States. Although Lake Michigan and Lake Huron have equal water levels, Lake Michigan is deeper, reaching 925 feet. It is 307 miles long and 118 miles wide.

Because they are connected, Lake Michigan and Lake Huron act as one lake. However, Lake Michigan is more intensively used than Lake Huron for drinking water, industry, transportation, recreation, and a host of other uses.

The moderating effect of Lake Michigan on near shore climate is one of several factors that have combined to make Michigan one of the leading fruit growing states and the third largest wine producer in the United States.

The 1,659 miles of Lake Michigan shoreline (including islands) contain the largest assemblage of sand dunes on any body of fresh water. These dunes are important to Michigan's tourism industry, and they must be respected as a fragile component of a unique ecosystem to be protected from damaging development.

Lake Erie

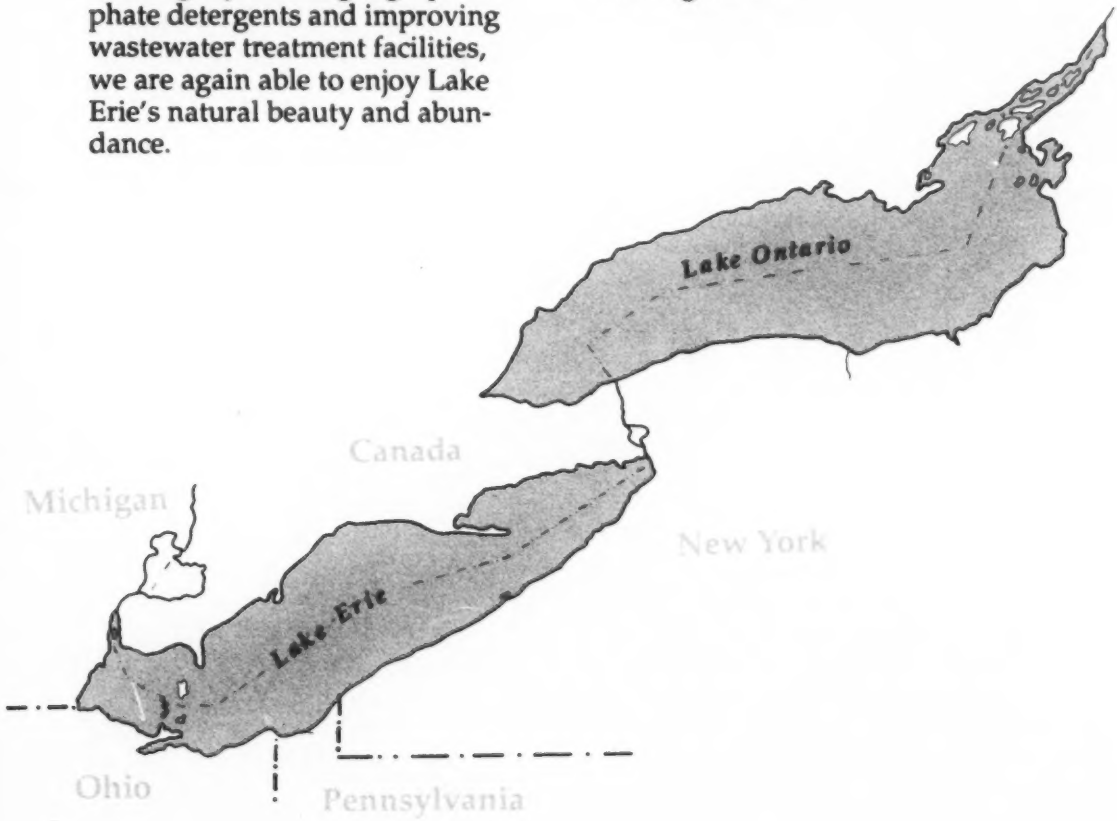
Lake Erie, 210 miles long and 57 miles wide, is an angler's dream. It not only commercially outproduces all the other Great Lakes, but is home to one of the best freshwater sport fisheries in the world. Numerous fish species including walleye, yellow perch, smallmouth bass, channel catfish, white bass and fresh water drum abound in its waters.

Written off 20 years ago as a "dead lake" because of pollution and contamination, Lake Erie today is very much alive and thriving. By banning high-phosphate detergents and improving wastewater treatment facilities, we are again able to enjoy Lake Erie's natural beauty and abundance.

Lake Ontario

Although the smallest of the Lakes in surface area, spanning 193 miles by 53 miles, it is the third deepest, reaching 804 feet at its maximum depth. The shoreline stretches 726 miles and is virtually free from hills, bays, rocks, and islands.

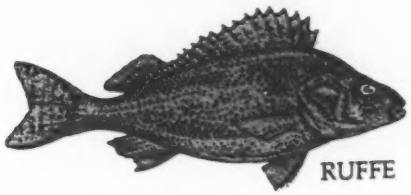
Bordered by Niagara on the west, Lake Ontario supplies some 24 million gallons per day to area crops and livestock. The most eastern lake in the system, its gentle breezes and climate create a model place to grow grapes, fruit, and vegetables.



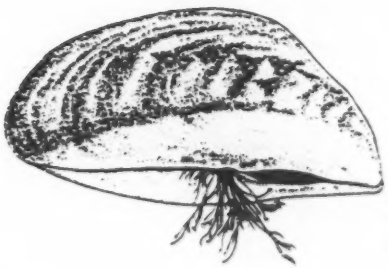
Great Lakes Environmental Concerns

The environmental problems of the Great Lakes are multi-faceted and leave us with a complex assignment—the protection and conservation of these natural resources.

Some of the challenges facing us include wetland protection, control of non-native species (such as the zebra mussel and the perch-like fish known as the river ruffe), management and cleanup of toxic chemicals, and pollution prevention through re-use and recycling.



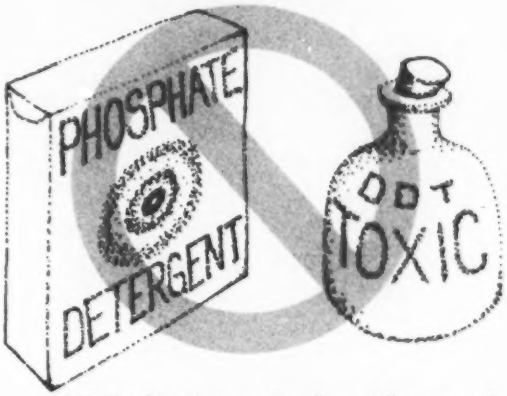
RUFFE



ZEBRA MUSSEL

Great Lakes water pollution problems are not new. They go back to the 19th century, and contributed to the signing of the Boundary Waters Treaty in 1909-a treaty to provide binational management of the Great Lakes. That Treaty created the International Joint Commission (IJC). The IJC oversees the implementation of the Water Quality Agreement which provides a binational framework and strategy to protect and preserve the Great Lakes.

The types of pollutants and our understanding of pollution, however, have changed over time. We have made enormous progress in controlling conventional pollutants (phosphorus and suspended solids) by building and improving wastewater treatment plants and banning high phosphate detergents.



With the increasingly wide use of chemicals over the past 50 years, new problems emerged—toxic pollutants. Toxic pollutants are man- made chemicals and metals that can be poisonous in small quantities and cause health problems or even death. For example, DDT, a pesticide, caused reproduction failure in eagles, ospreys and peregrine falcons. Michigan was the first state to ban DDT in 1969.

Widespread use and careless handling of toxic materials has contaminated the Great Lakes, especially bottom sediments. Some of these contaminants exist at levels that directly affect the health of living organisms. Others can build up to harmful levels in an organism's tissues through a process known as bioaccumulation. Bioaccumulation results when the organism eats contaminated prey or lives in contaminated water. Toxic substances entering the Great Lakes have been substantially reduced in the past decade

through wastewater discharge limitations and regulations, and the banning or restriction of certain highly-hazardous compounds such as DDT and PCB. However, some sediment pollution remains.

Cleaning up our waters and keeping them clean requires more than controlling waste, air and runoff pollutants. We understand that runoff from city streets and farmers' fields, as well as toxic contaminants in the air can cause serious Great Lakes pollution. The Great Lakes are not limitless. They are extremely vulnerable and at risk. They need our protection.

In 1986 the Great Lakes governors recognized toxic contamination as the Great Lakes' foremost environmental problem by signing the Toxic Substances Control Agreement. This Agreement committed the eight states to working together cooperatively to clean up toxic contamination of the Great Lakes.

Education - The Key To Tomorrow

The information presented here is a brief overview of the Great Lakes. Over the next five years, the Department of Natural Resources and the Office of the Great Lakes will develop teaching materials to provide opportunities to explore specific Great Lakes issues in greater depth and detail. The Great Lakes Education Program will focus on specific areas like sand dunes and coastal wetlands, Great Lakes water quality, shipping and navigation, and Great Lakes history and geography.

We would appreciate your comments and your participation as we continue to develop Great Lakes educational materials . Please contact the Office of the Great Lakes, Michigan Department of Natural Resources, Box 30028, Lansing, MI, 48909, phone (517) 373-3588, with your thoughts and suggestions.

Thank you on behalf of our truly Great Lakes!

Great Lakes Score Card

1. Which Great Lake is the biggest fresh water lake in the world?

_____

2. Name three fish found in the Great Lakes.

_____

3. Name three of Michigan's Great Lakes Indian tribes.

_____

4. Which Great Lake is completely within the United States?

_____

5. Which is the smallest Great Lake (in surface area)?

_____

6. Where are the Niagara Falls?

_____

7. What countries and states surround the Great Lakes?

_____

8. List three Great Lakes wildlife species.

_____

9. Name three of the Great Lakes' pollution problems.

_____

10. What Great Lake is closest to your school?

_____

Great Lakes Resource Guide

Directory of Great Lakes Educational Material
Published by the Great Lakes Science Advisory Board
International Joint Commission, 1989
Copies provided by:
Information Services
P.O. Box 32869
Detroit, Michigan 48232-2869
(313) 226-2170

The Conservation Catalog-A Resource Guide for Michigan Environmental and Conservation Educators
Published by Michigan United Conservation Clubs
Copies may be purchased from:
MUCC
2101 Wood Street/P.O. Box 30235
Lansing, Michigan 48909
(517) 371-1041

Great Lakes Education Speakers Bureau Directory
Published by The Great Lakes Commission, 1989
Copies provided by:
The Great Lakes Commission
The Argus II Building
400 South Fourth Street
Ann Arbor, Michigan 48103-4816
(313) 665-9135

Directory of Air Quality Educational Materials, March 1989
Copies prepared and provided by:
Air Quality Division,
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-7023

Natural Heritage Information - Educational Materials Listing
Copies prepared and provided by:
Natural Heritage Program, Nongame Unit
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-1263

4-H Natural Resources and Environmental Education-Materials Listing
Copies prepared and sold by:
4-H Youth Programs
Cooperative Extension Service
Department of Fisheries and Wildlife
Michigan State University
East Lansing, Michigan 48824
(517) 355-0180

Great Lakes Issues Information

Great Lakes Notebook, Fourth Coast Facts and Issues
Copies can be obtained from:
Office of the Great Lakes
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-3588

Great Lakes Toxic Hotspots: A Citizen's Action Guide
Copies can be obtained from:
Lake Michigan Federation
8 S. Michigan Avenue, Suite 2010
Chicago, Illinois 60603
(312) 263-5550

Toxic Substances in the Great Lakes (EPA 905/9-80-005)
Copies can be obtained from:
Great Lakes National Program Office
United States Environmental Protection Agency, Region 5
230 S. Dearborn Street
Chicago, Illinois 60604
(312) 353-2117

Maritime Museums

Dossin Great Lakes Museum
100 Strand on Belle Isle
Detroit, Michigan 48207
(313) 267-6440

S.S. Keewatin
P.O. Box 511
Douglas, Michigan 49406 (Saugatuck)
(616) 857-2107

Marquette Maritime Museum
Lakeshore Blvd.
Marquette, Michigan 49855
(906) 226-2006

Northwest Michigan Maritime Museum
324 Main Street/P.O. Box 389
Frankfort, Michigan 49635
(616) 352-4122

Lake Michigan Maritime Museum
P.O. Box 534
South Haven, Michigan 49090
(616) 637-8078

Mackinac Point Lighthouse Museum
P.O. Box 873
Mackinaw City, Michigan 49701

U.S.S. Silversides (World War II Sub)
and Great Lakes Naval & Maritime Museum
P.O. Box 1692
Pere Marquette Park
Muskegon, Michigan 49443
(616) 722-3751

Beaver Island Marine Museum
P.O. Box 263
St. James, Michigan 49782
(616) 448-2254

Shipwreck Memorial Museum
Whitefish Point Road
Paradise, Michigan 49768
(906) 492-3436

Educational Opportunities

Schoolships

The Malabar/The Madeline
For more information, contact Tom Kelly
Inland Seas Education Association
P.O. Box 4223
Traverse City, Michigan 49685
(616) 271-6637

The D.J. Angus
For more information, contact Tanya Cnossen
Water Resources Institute
Grand Valley State University
Allendale, Michigan 49401-9403
(616) 895-3749

Short Courses\Workshops

Higgins Lake Environmental School
For more information, contact Gay Cowles
Public Information
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-2199

4-H Great Lakes and Natural Resources Camp for Leaders/Teachers
For more information, contact Lowell Rothert
4-H Youth Programs
Cooperative Extension Service
Michigan State University
East Lansing, Michigan 48824
(517) 355-0341

Marine Safety Training for 6th Grade Youngsters
For more information, contact the
Law Enforcement Division
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-1230

International Joint Commission Great Lakes Teacher Workshops
For more information, contact Sally Cole-Misch
International Joint Commission
P.O. Box 32869
Detroit, Michigan 48232
(313) 226-2170

Educational Tools

Gulliver the Talking Gull
For more information, contact Alice Tibbetts
Minnesota Sea Grant College Program
116 Classroom-Office Building
University of Minnesota
1994 Buford Avenue
St. Paul, Minnesota 55108
(612) 625-9288

The Water Resource Series: Understanding Lake Ecology, Understanding Groundwater, Understanding Wetlands.
Each kit includes a full-color filmstrip, a narrative cassette tape, and a teacher's manual with supplemental materials designed to generate classroom discussion, references and suggested activities.
For more information, contact Information Services Center
Office of Public Information
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-1214

The Jason Project, high-tech undersea discovery program offered through the Detroit Science Center
For more information,
contact the Detroit Science Center
5020 John R. Street
Detroit, Michigan 48202
(313) 577-8400

Michigan Department of Natural Resources
Great Lakes Educational Facilities

Sand Dune Visitor Center
P.J. Hoffmaster State Park
Muskegon, Michigan
(616) 798-3711

Great Lakes Visitor Center
Ludington State Park
Ludington, Michigan
(616) 843-8671

Michigan Fisheries Interpretive Center
Mattawan, Michigan
(616) 668-3388

Platte River State Fish Hatchery
Honor, Michigan
(616) 325-4611

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Special Thanks to:
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Sharon Goble, Editor and Project Manager
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Tina Stojakovich, Graphics

Michigan Council on Environmental Quality
P.O. Box 30195
Lansing, Michigan 48909
517-335-9095

October 15, 1990

Dear Educator:

The Michigan Council on Environmental Quality is pleased to offer you an environmental awareness program designed for students. The Council has prepared a **YOU CAN MAKE A WORLD OF DIFFERENCE!** card which can be used to stimulate discussion about our natural resources and the need to be aware of the three environmental Rs - Reduce, Reuse, and Recycle.

The theme "You can make a world of difference" is meant to convey that individual choices are important to our environmental well-being and essential to preserving the earth for future generations. We hope to instill good conservation habits at an early age by asking students to "pledge" their willingness to make such habits a part of their everyday lifestyle. Specific activities are presented for conserving water, saving energy, and reducing waste.

If you would like to use this program for a class project, we will provide you with cards on which students can mark the activities they are willing to do and sign their name, along with their age and the school they attend. We would like you to collect the signed cards and mail them to the Council so that we can provide reports on the environmental savings that the students are accomplishing, as well as encouraging their continued commitment to making Michigan - and the world - a better place to live!

Please contact the Council to order the number of cards you will need for your class. We will also provide you with a postage-paid envelope to return the signed cards. You can call our toll-free number 1-800-292-0528 or write to The Council on Environmental Quality, P.O. Box 30195, Lansing, 48909.

Thank you for your interest.

Sincerely,

Elizabeth Harris

Elizabeth Harris, Chair
Council on Environmental Quality

RECYCLED PAPER

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JAMES J. BLANCHARD
GOVERNOR

August 22, 1990

Dear Educator:

The Great Lakes confer upon our state a very special mantle of environmental stewardship. The stunning beauty of these freshwater seas serve to remind us that we must be ever vigilant in protecting and preserving them.

As the only state in the nation to lie almost entirely within the Great Lakes basin, Michigan has an unparalleled responsibility. We are the keepers of the Great Lakes, the crown jewels of our water resources. To protect and preserve these magnificent natural resources, it is imperative that we learn about the importance of the Great Lakes and our connections with them.

Last year I asked you to set aside one day for Great Lakes education. This year I have designated the week of September 24- 28 as Great Lakes Education Week. I hope that you will dedicate time during that week to use this booklet and the enclosed materials to assist your students in learning about the Great Lakes.

During Great Lakes Education Week, you and your students will be able to hear Great Lakes Moments public service announcements. You might also consider field trips to Michigan State Park Interpretive Centers, Great Lakes museums, or schoolships.

In a world with rapidly changing needs, we must sharpen our focus to give today's students the tools they need to protect the Great Lakes and solve tomorrow's environmental problems.

This Great Lakes Educational Booklet introduces a five-year educational program which will help open the doors to environmental science and educate tomorrow's stewards of our resources.

We look forward to working with the education community to provide the knowledge and information necessary to assure that the Great Lakes are forever protected and preserved.

Sincerely,

Jim Blanchard

James J. Blanchard
Governor

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THE GREAT LAKES

Formed over a span of 2 million years by glacial and geological action, the Great Lakes took their most recent form almost 10,000 years ago — at the end of the last ice age. Lakes Superior, Michigan, Huron, Erie and Ontario are joined by rivers and other connecting channels to form the largest surface freshwater system in the world.

Lake Superior has the largest surface area of any freshwater lake in the world. Lake Huron, the second largest of the Great Lakes, is the fifth largest lake in the world. Lake Michigan, the only Great Lake totally within U.S. boundaries, is the world's sixth largest lake. Lake Erie, the eleventh largest freshwater lake in the world (by surface area), is the shallowest of the Great Lakes. Lake Ontario, the smallest of the system in surface area, is the fourth deepest and the fourteenth largest lake on Earth.

WATER USE

The Great Lakes provide water for many purposes, such as domestic uses (residential, commercial, institutional); industrial processes; agricultural operations (irrigation and livestock watering); electric power generation (fossil fuel, hydroelectric and nuclear); navigation; sanitation; recreation; and habitat for aquatic life. In 1987, the Great Lakes basin states and provinces began to maintain more complete usage records, but not all jurisdictions were able to provide accurate information for each lake basin. The following are conservative estimates.

Total Usage: 655 billion gallons per day (bgd) or about 2.5 trillion litres per day (tld) are used for various purposes. This amount would fill a train of more than 19 million jumbo tanker cars, each 65 feet long, holding 34,000 gallons. The train would be over 237,000 miles long and would circle Earth at the equator more than nine and one-half times.

Ninety-four percent of the water passes through hydroelectric production plants and is returned to the Great Lakes ecosystem. Approximately 1,000 gallons per Great Lakes basin resident (37 bgd/140 bld) is used daily for other purposes. Almost 97 percent of this amount is returned to the system; the remaining 3 percent leaves the system either through evaporation or through incorporation into products and is considered "consumed."

Drinking Water: Approximately 25 million people get their drinking water from the Great Lakes and St. Lawrence River. This number includes 5 million

GREAT LAKES BASIN

Recreation/Tourism: Recreation/tourism is often called the region's second largest industry, and Great Lakes states have spent as much as $11 million on tourism promotion annually since 1986. Approximately 700,000 U.S.-registered recreational boats are used on the Great Lakes each year. In 1987, an estimated 800,000 pleasure boats registered in Ontario were used on the Great Lakes. Recreational diving on shipwrecks is a growing Great Lakes sport, especially in the eight underwater preserves and parks located in lakes Superior, Michigan and Huron. The average diver spent more than $1,200 (U.S.) on Great Lakes diving trips in 1986. Great Lakes recreation also includes such activities as windsurfing, kayacking, dune climbing, rockhunting, sunbathing, hiking, birdwatching and picnicking.

RESOURCE ISSUES

The Great Lakes ecosystem consists of the water, surrounding land, air and all living organisms (including humans) in the basin. The issues, problems and challenges facing the Great Lakes basin include water quality; fisheries management; transportation; widely fluctuating water levels, shoreline erosion and coastal flooding; diversions and consumptive uses; wetland drainage and land use; waterfront revitalization, public access, recreation and tourism; the complexity of management institutions; and research, monitoring, surveillance and enforcement of environmental laws and agreements.

The Great Lakes and the St. Lawrence River are bordered by eight states — Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York — and two Canadian provinces — Ontario and Quebec. These jurisdictions, along with the federal governments of the two countries, are responsible for managing the lakes.

Water Levels: Great Lakes water levels fluctuate primarily because of variations in the amount of precipitation falling on the lakes and surrounding land and changes in evaporation from those surfaces. Levels normally vary somewhat from season to season — from high during winter and spring to low during summer. If there is exceptionally heavy rain/snowfall with cooler-than-average temperatures, the levels are likely to rise beyond the seasonal variation, and they can also decline quickly. Such wide fluctuation in lake levels can affect the shipping industry, power generation, recreational opportunities, shoreline erosion and wildlife habitat.

Michigan water, but many of whom live outside the basin boundary.

Power Generation: An average of 20 billion kilowatt hours of electricity are generated annually by using Great Lakes water. An average of at least 640.4 bgd was withdrawn for this purpose in 1987, and hydroelectric production used almost 97 percent (620 bgd/2.3 tld). This was by far the largest quantity of Great Lakes water withdrawn for a single purpose.

Agriculture: An average of 300 mgd in 1987.

Industry/Manufacturing: (self-supplied, that is, not served by a municipal system): 7.7 bgd in the jurisdictions reporting in 1987.

Diversions: In 1987, 1.9 bgd/7.2 bld of water were diverted into the Great Lakes system through the Long Lac and Ogoki diversions into Lake Superior. This amount was somewhat lower than the long-term average of 3.6 bgd/13.7 bld. In addition, 1.6 bgd or 6 bld is diverted out of the Great Lakes, most of it at Chicago into the Mississippi River basin.

ECONOMIC IMPORTANCE

The Great Lakes play an important role in the region's manufacturing, agriculture, transportation, tourism, and fishery. Many industries first developed near the lakes because of the availability of abundant, cheap clean water and a means of accessible, efficient transportation. Likewise, the Great Lakes region has a profound influence on the world's economy.

Great Lakes Shipping: The Great Lakes are an important inland transportation route for the large scale movement of coal, iron ore, limestone, sand and a variety of grains. In 1987, 63.3 million net tons of iron ore, 37.7 million tons of coal and 22.7 million tons of grain were transported on the Great Lakes. That year, 40 million metric tons of cargo moved through the St. Lawrence Seaway on some 5,000 vessels.

Industry: In 1986, about 17 percent of the United States' manufacturing industry was located in the Great Lakes basin.

Steel Production: 72 percent of Canadian and 45 percent of U.S. production occurs in the Great Lakes basin (70 percent in the Great Lakes states).

Shipbuilding: Two major shipyards are located on the Great Lakes, at Port Weller, Ontario, and at Sturgeon Bay, Wisconsin.

Auto Production: 41.5 percent of U.S. cars and 37.3 percent of U.S. trucks and buses are manufactured in the Great Lakes region. 94.7 percent of Canadian car and truck production occurs in the region.

Power Generation: Electric power generation in the Great Lakes states and Ontario is estimated at 826.9 billion kilowatt hours annually.

Agriculture: The Great Lakes help to moderate the region's climate and supply ample water for irrigation, so agricultural production ranks among the top three contributors to the region's economy. Great Lakes states produce 49 percent of U.S. corn and much of U.S. and Canadian beans, sunflower seeds and dairy products. Orchards, particularly apple and cherry, and vineyards are located along the shores of several Great Lakes. Cheese factories, breweries and canneries depend on Great Lakes water. Twenty-two percent of Canadian farms are located in the Great Lakes basin, and they account for 25 percent of total Canadian agricultural production.

Forestry: Almost half the United States' area of the Great Lakes basin is forested. Paper production has developed at Green Bay in the United States and throughout the Lake Superior region. However, some authorities think that lack of reforestation in some areas of the Great Lakes basin may reduce the forestry resource in the future.

Fishery: Commercial fishing — Ontario commercial fishers caught 48 million lb (22 million kg) in 1987; 41.2 million lb (18.7 million kg) were caught in the U.S. The dockside value of the fish caught commercially in Canada was about $46 million (Canadian dollars-CDN), while the value of U.S.-caught fish was nearly $18.8 million (U.S. dollars). The commercial fishery has a regional economic impact more than four times the dockside value (the money paid for the catch at the dock). Sportfishing — The Great Lakes states sold nearly 9.5 million fishing licenses in 1987, many of them for use on the Great Lakes or their tributaries. Anglers spent the equivalent of 46.4 million days sportfishing on the U.S. waters of the Great Lakes in 1985, with a regional economic benefit of about $1.56 billion (U.S.). Sportfishing on Canadian Great Lakes waters that year totalled more than 14.6 million angler days, with expenditures amounting to almost $351.5 million (CDN). In 1987, approximately 3,000 charter fishing boats were operating on the Great Lakes. Michigan charter fishing clients alone spent $39 million for charter fees and trip expenses.

the lakes is generally good. However, industrial, municipal and recreational uses of the Great Lakes add pollutants to the ecosystem. Some pollutants may stay in the water or lake sediments for hundreds of years and affect the ecosystem. The types of problems include: toxic substances in water, sediments, fish and other organisms living in or depending on the water; elevated levels of bacteria; high levels of phosphorus and other nutrients; heavy metals; and aesthetic problems. Pollution is usually most severe in major population centers on Great Lakes rivers, harbors and connecting channels. The types and severity of problems vary among these "areas of concern" (AOCs).

The federal governments developed the Boundary Waters Treaty (1909) and the Great Lakes Water Quality Agreement (1972, 1978 and amendments in 1987), along with laws and programs such as the U.S. Clean Water Act, the Canadian Environmental Protection Act and the $125 million Great Lakes Action Plan to protect and improve the ecosystem. In 1985, the Great Lakes states and provinces agreed to clean up and restore 42 AOCs. Responsible jurisdictions are developing "remedial action plans" (RAPs) to control and stop existing sources of pollution and restore water quality in each AOC. The states have signed a Toxic Substances Control Agreement, and the Province of Ontario has begun a Municipal-Industrial Strategy for Abatement (MISA). The Council of Great Lakes Governors has established a Great Lakes Protection Fund to support research on toxic substances problems.

Fisheries: The Great Lakes fishery consists of a blend of such native species as lake trout, lake whitefish, lake herring, lake sturgeon, yellow perch, walleye and bloater chubs, and others such as coho and chinook salmon and rainbow trout, that were introduced and are restocked regularly by state and federal fishery management agencies to enhance recreational opportunities for the public. Between 1958 and 1984, more than 450 million fish of various species were planted in the Great Lakes. Some introduced species are beginning to reproduce naturally in the lakes.

Among the challenges to the fishery are (1) maintaining a sustainable forage base; (2) controlling exotic species such as sea lamprey, river ruffe and zebra mussels; and (3) eliminating toxic substances. The states and provinces cooperate in Great Lakes fishery management through the Great Lakes Fishery Commission and have developed cooperative fish consumption advisories.

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Great Lakes Basin

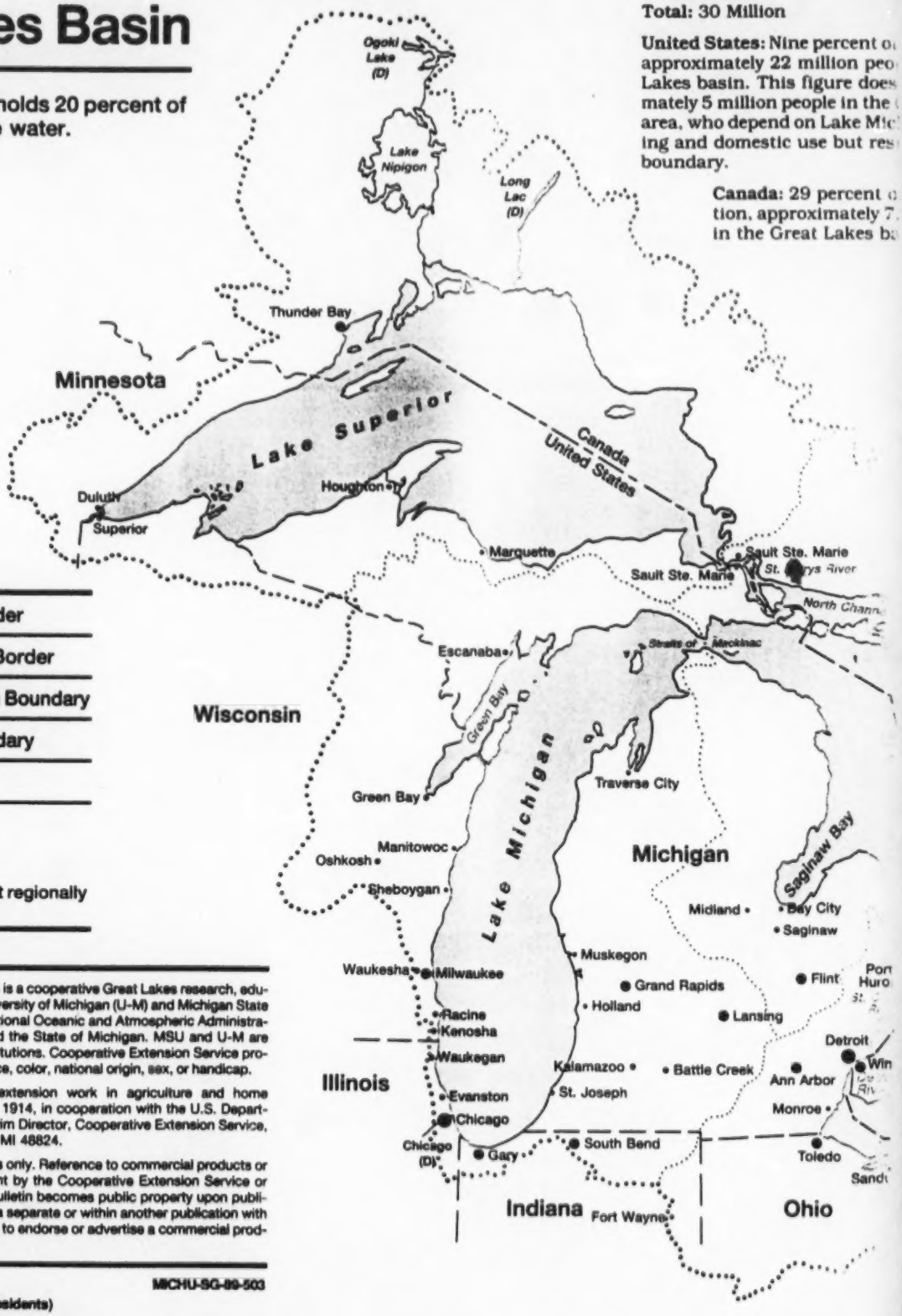
The Great Lakes system holds 20 percent of the world's fresh surface water.

POPULATION

Total: 30 Million

United States: Nine percent o approximately 22 million peo Lakes basin. This figure does mately 5 million people in the area, who depend on Lake Mic ing and domestic use but res boundary.

Canada: 29 percent o tion, approximately 7. in the Great Lakes b



LEGEND

- International Border
- State/Provincial Border
- Great Lakes Basin Boundary
- Lake Basin Boundary
- (D) Diversion
- Metro Areas
- 100,000+
- 50,000-99,999
- less than 50,000 but regionally important

The Michigan Sea Grant College Program is a cooperative Great Lakes research, education and Extension program of The University of Michigan (U-M) and Michigan State University (MSU). Funding is from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and the State of Michigan. MSU and U-M are Affirmative Action/Equal Opportunity Institutions. Cooperative Extension Service programs are open to all without regard to race, color, national origin, sex, or handicap.

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Revised 1:90 30M-KDP-LB **MICHU-SG-89-503**

25 cents (Single copy free to Michigan residents)

File: 28.32 or 23.21 (Great Lakes Resource Management)

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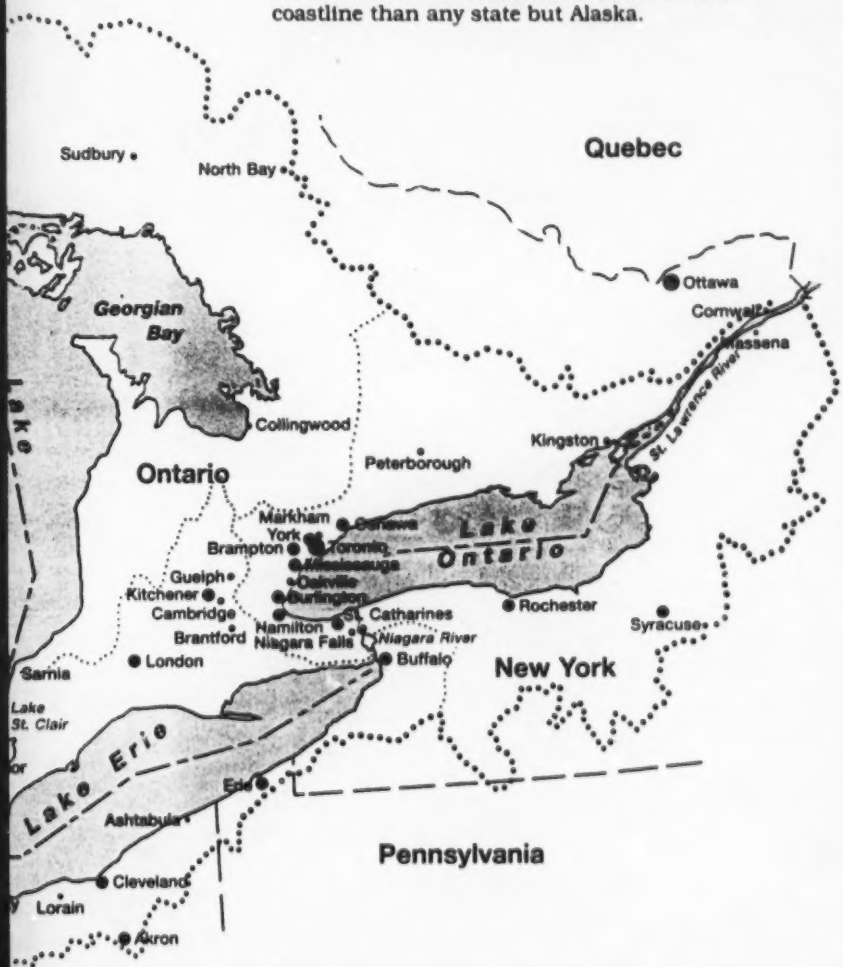
DIMENSIONS

Volume: 6 quadrillion gallons of fresh water; one-fifth of the world's fresh surface water (only the polar ice caps and Lake Baikal (USSR) contain more); 95 percent of the U.S. supply. Spread evenly across the continental U.S., the Great Lakes would submerge the country under about 9.5 feet of water.

Total Area: Over 94,000 mi^2/244,000 km^2 of water (larger than the states of New York, New Jersey, Connecticut, Rhode Island, Massachusetts, Vermont, and New Hampshire combined, or about 23 percent of the province of Ontario). In the watershed (the area where all the rivers and streams drain into the lakes), about 295,000 mi^2/767,000 km^2.

Total Coastline: United States and Canada — 11,232 mi/18,059 km (including connecting channels, mainland and islands). The Great Lakes shoreline is equal to almost 45 percent of the circumference of the earth, and Michigan's Great Lakes coast totals 3,288 mi/5,294 km, more coastline than any state but Alaska.



SPONSORS/INFORMATION SOURCES

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International Joint Commission
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Windsor, ON N9A 6T3 (519) 256-7821
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Detroit, MI 48232-2869 (313) 226-2170

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Environment Canada
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25 St. Clair Avenue East, Room 600
Toronto, ON M4T 1M2 (416) 973-6467
or
Ontario Ministry of the Environment
Public Information Centre
135 St. Clair Avenue West
Toronto, ON M4V 1P5 (416) 323-4321

Great Lakes Commission
The Argus Building II
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Ann Arbor, MI 48103-4816 (313) 665-9135

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The Center for the Great Lakes
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Chicago, IL 60611 (312) 645-0901
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The Centre for the Great Lakes Foundation
320 1/2 Bloor Street, West, Suite 301
Toronto, ON M5S 1W5 (416) 921-7662

Other publications in this series are: Lake Superior (E-1866, MICHU-SG-89-504); Lake Michigan (E-1867, MICHU-SG-89-505); Lake Huron (E-1868, MICHU-SG-89-506); Lake Erie (E-1869, MICHU-SG-89-507); and Lake Ontario (E-1870, MICHU-SG-89-508). For additional copies, contact one of the organizations listed above, your county Extension office, or the MSU Bulletin Office, 10-B Agriculture Hall, East Lansing, MI 48824-1039.

RECYCLED PAPER

This beautiful wildlife poster is brought to you by the thousands of citizens who have contributed to the Nongame Wildlife Fund on their state tax form or by direct donation to the fund. It portrays the unique, fragile beauty and ecological value of sand dune habitats, one of the most important elements of Michigan's rich natural heritage.

MICHIGAN COASTAL DUNES

INTRODUCTION

Michigan's shoreline is a showcase for 275,000 acres of sand dune formations. An interaction between blustery winds and waves has moved and carved fine sands into the largest display of freshwater dunes in the world. These beautiful sand formations contain a diversity of life, climatic conditions, and geological relief unique to Michigan.

A visit to a sand dune provides an opportunity to experience a landscape of natural sounds, smells, and sights. Feeling the clean sand beneath your feet as the fresh lake breezes bathe your face is one of the values of Michigan's magnificent sand dunes. We have a responsibility to protect and preserve this natural legacy for the enjoyment and wise use by our present and future generations.

We hope this poster will enhance your enjoyment and appreciation of the sand dune ecosystem by introducing you to its geology and ecology, as well as to the human impact on this unique, fragile environment.

GEOLOGY

Michigan's glacial history provides an explanation for the formation of dunes. The Great Lakes dune complex is relatively young, in terms of geological time. As recently as 16,000 years ago, Michigan was covered with glacial ice thousands of feet thick. This glacial ice contained a mix of boulders, cobbles, sand, and clay. During glacial melting, this deposit was left and is known as glacial drift.

This glacial drift is the source of sand in most of Michigan's dunes. The sands were either eroded from glacial drift along the coast by wave activity or eroded from inland deposits and carried by rivers and streams. Only the hardest, smallest, and least soluble sand grains were moved. Waves and currents eventually moved these tiny rocks inland, creating beaches along the Great Lakes shoreline.

DUNE FORMATION

Winds, blowing shoreward at speeds of 8 to 25 miles per hour, begin to move the sand grains. The size of grains which are moving is directly related to wind velocity—larger grains require higher wind speeds. These bouncing sand grains resemble tiny, skipping ping pong balls as they are moved by the wind through a process called saltation (see Figure 1). Colliding with each other, barely a foot or two off the ground, they may meet a slight obstruction, such as a clump of grass, which deflects the wind and allows sand grains to drop. Thus a slight mound or hummock is created.

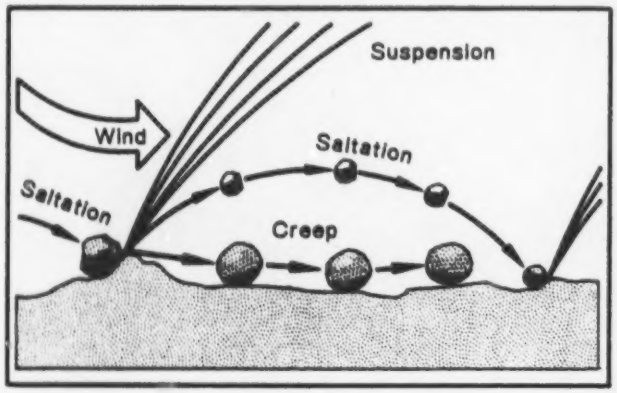


Figure 1, Sand movement by wind: saltation and surface creep.

The wind continues to push sand grains up the windward side of the dune crest, causing the dune to grow in the downwind direction. Many sand grains continue moving and eventually roll down the steep backslope. A dune is slowly being formed, and its continued growth depends upon perennial vegetation, wind, and sand. Because dune plants act as barriers to sand movement and hold migrating sand, they play a critical role in the formation and stabilization of dunes.

MAJOR DUNE TYPES

Parallel dunes are series of low, linear dunes formed parallel to the shores of large shallow bays. The parallel dunes along the eastern shore of Lake Michigan were formed about 4,000 years ago during the Lake Nipissing stage of Lake Michigan, when water levels were 25 to 30 feet higher than present day Lake Michigan water levels. Rivers entering the bays carried abundant sand, which was then moved along the shore by lake currents.

On-shore winds formed these sands into low-lying dunes. As the water level of ancient Lake Nipissing dropped, a series of parallel dunes were created. They occurred in areas that were formerly wide bays in Lake Nipissing.

Today, some examples of parallel dune complexes can be seen at the mouth of rivers, including the Muskegon, Kalamazoo, and Grand. Remnants of several ancient bays now are coastal lakes, such as Hamlin Lake in Mason County, Silver Lake in Oceana County, and White Lake in Muskegon County.

Blowouts are saddle-shaped or U-shaped (parabolic) depressions in a stabilized sand dune, caused by the local destabilization of the dune sands. Blowouts, which originate on the summit or windward face of a dune, are often rapidly formed by the wind, creating narrow channels and exposing plant roots. Blowouts can create interruptions in the shape of parallel dunes that may result in deeply carved indentions called **parabolic dunes** (see Figure 2). It is the combination of interwoven parallel dune ridges and U-shaped depressions, including parabolic dunes, that characterizes the classic dunes from Indiana, northward to Ludington, in Michigan.

The moving sand from the blowouts often buries forests on the steep lee slopes. Blowouts may also uncover the bleached trunks of trees still standing after being buried in the dry sand for hundreds of years. These "ghost forests" are silent testimonials to ancient forests buried by blowouts in the past.

Blowouts have historically been caused by natural disturbances, such as fires, wind storms, or plant diseases. However, in recent decades, human activities and disturbance or destruction of sand-holding vegetation has initiated blowouts. Off-road vehicle traffic and human foot traffic are major causes, but clearing of protective dune vegetation to build homes, cottages, and commercial buildings has also resulted in large-scale wind erosion—man-made blowouts. Continuous human disturbance has the potential for much more widespread destabilization because it does not allow blowouts to stabilize.

Perched dunes are some of the more famous and most spectacular land features in Michigan. They are actually wind-blown sand dunes perched atop glacial moraines. Glacial moraines, common landforms in Michigan, are ridges of sand, gravel, stone or clay left by retreating glacial ice. The moraines lying along the present shoreline of the Great Lakes were subjected to wind and wave erosion. Sand, moved by waves and long-shore currents, was blown up the steep faces of the moraines by on-shore winds, accumulating along the summits and leeward sides, forming perched dunes. The famous dunes at Sleeping Bear Dunes National Lakeshore are a well-known example. Others include those on the Manitou and Fox Islands in northern Lake Michigan and Grand Sable Banks near Grand Marais in Lake Superior.

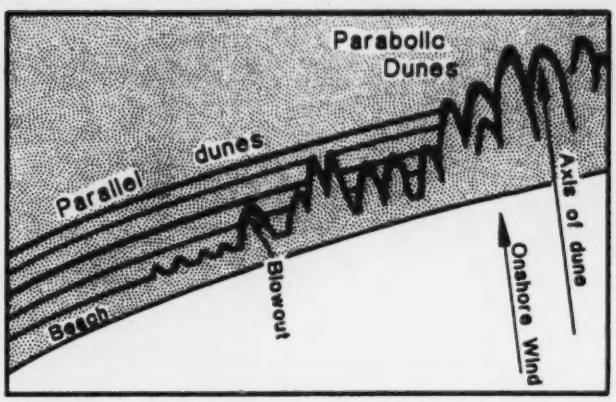
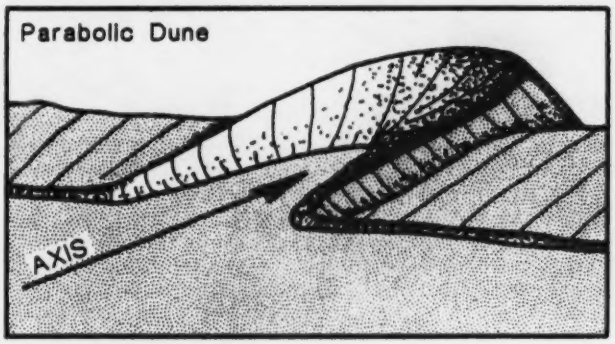


Figure 2, A blowout and parabolic dune interruption of a Michigan shoreline. From: Bird, 1969, page 139



DUNE LIFE ZONES

The dune ecosystem is made of several zones with very different physical characteristics. They are as follows:

Beaches are zones where water meets land. The constant movement of sand by the wind, pounding storm waves, and winter ice and snow make this a formidable habitat for any living thing. For this reason, few plants or animals live on the beach. Most wildlife seen there are just visitors. Among these visitors are scavengers ranging in size from small flies and beetles to shore birds, herring gulls, and even bald eagles. The remains of fish, birds, and insects washed ashore provide food.

Mammals that venture down to the beach include the raccoon, skunk and fox, which wait until dark to search the shoreline for food. A recent study conducted on North Manitou Island revealed an unexpected scavenger: white-tailed deer that feed on dead alewives.

The sea rocket is one of the few plants specially adapted to withstand the pounding of waves and other adverse conditions. It sinks its roots to the water table and stores water in its succulent leaves.

The **foredune** is the first ridge behind the beach. Although foredunes are above wave action most of the time, they are regularly subject to storm waves.

Like the beach, life in the foredune is a daily struggle against shifting sand, scarcity of nutrients, rapid water drainage, high evaporation rates, and storms. Out of the reach of waves, a few hardy plants, such as marram grass and sand reed grass, are able to survive. These grasses are known as pioneer species, because they are one of the first plants to become established, and they create habitat for other plants by stabilizing the soil with their extensive root systems, thus increasing the soil's capacity to retain water and nutrients. Marram grass spreads quickly by sending stems to the surface to form new plants. As drifting sand accumulates in the marram grass, the central stem continues to grow, keeping the plant's leaves exposed to the sun and air. This keeps the grass from being buried and increases the height of the foredune.

A foredune stabilized by these grasses can host a wide variety of wildflowers and shrubs. They include beautiful clusters of the yellow hairy puccoon, the common milkweed, beach pea, sand cress, smooth rose, bearberry, poison ivy, wild grape and sand cherry. Foredunes will remain stable as long as the vegetation is undisturbed.

Unlike plants, animals can escape the extreme temperatures and harsh conditions. Most birds migrate seasonally or retreat daily to the cover of heavy vegetation. Many animals are nocturnal and are most active during the cooler nighttime hours. Like the plants, animals that live on the grass-covered foredune have special adaptations that help them survive the extreme temperatures of summer and winter. Surface temperatures on the open dunes can reach 120 degrees Fahrenheit. The sand wolf spider is adapted to extreme temperatures by living in a burrow deep under the sand. Its sandy brown color also helps it blend into its surroundings when leaving its burrow home.

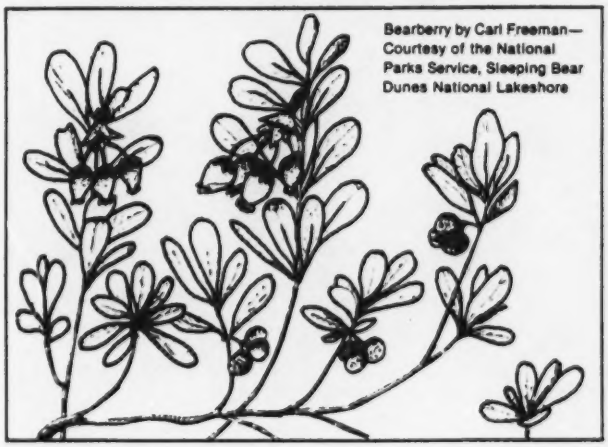
Interdunal wetlands are shallow ponds or pools located between dunes. They typically are found between low dunes or sand spits created when water levels drop or as shoreline currents change. Ponds may vanish during dry periods. These fluctuations in water table are important for plants such as the threatened Houghton's goldenrod.

The animals and plants found in and around interdunal wetlands are similar to those inhabiting most ponds. Insects like water striders may skate across the surface. Whirligig beetles make erratic patterns on the surface. Shorebirds, like the greater yellow-legs, feed on the rich insect life. Spikerushes and sedges grow in the shallows.

Dune forests can be found on stabilized dunes protected from intense wind erosion. The dominant forest type varies as one travels north along the coastline. In southern Michigan dunes, oak-hickory forests are common. Northern dune forests are dominated by beech, maple and hemlock.

The uniqueness of dune forests stems from the fact that they develop on steep, barren sand slopes that are a short distance from open dunes. The contrast between the cool, shaded dune forest and the extreme temperatures and intense sunlight of the open dune can be striking. Though thin and slow to accumulate, the topsoil of dune forests supports a variety of spring wildflowers and woodland plants.

Studies of dune slopes reveal varying patterns of vegetation, depending on the direction of sunlight and the amount of shade, moisture, and protection from the wind. For example, Eastern hemlocks prefer shady, north-facing slopes. Spring wildflowers such as the white trillium bloom in abundance on south-facing slopes where they can absorb more sunlight.



Bearberry by Carl Freeman—Courtesy of the National Parks Service, Sleeping Bear Dunes National Lakeshore

DUNE PLANTS

Lichens, fungi, mosses, grasses, wildflowers, shrubs and trees all are part of a dunescape. All dune plants must adjust their survival to the harsh environment. Drying winds, low soil moisture and fertility, and intense sunlight along with blowing sand are conditions that affect the growth of dune vegetation. In the most active parts of the dune, only a few species of grass and shrubs can survive; on more protected areas, forests become established.

Dune plants have evolved special adaptations to the harsh environment. Some are gray-green and covered with tiny hairs that act like a reflective blanket, reflecting light to prevent heat loss and aiding in transpiration. The sea rocket, a member of the mustard family, has fleshy stems that hold moisture. Its root system is able to withstand continual wave action at the shoreline.

As sturdy as they seem, dune plants are especially sensitive to human disturbance. Walking or driving all-terrain vehicles on them may cause destruction of surface vegetation and root die-off. This exposes a dune to wind erosion, allowing the sand to move or open up channels in its form. **Without sand dune plants, the integrity and preservation of a stable dune complex cannot exist.**

ECOLOGY

Many of the fundamental concepts of plant succession and ecology were first identified as a result of studies made on Lake Michigan's sand dunes. The struggle of plant communities to pioneer and evolve on barren sand is a complex process known as succession, in which natural communities replace each other. Each stage of plant succession creates different microenvironments. These microenvironments are created by changes in temperature, moisture, and light intensity caused by plants and animals occupying the site.

Dune systems are well suited for the study of succession and ecological change because of the rapid changes which occur. For example, when drops in lake levels expose sand spits or create new foredunes, these features are rapidly colonized by beach grass. Within one or two human generations the vegetation can change from beach grass to shrubs to trees. Storms and high lake levels can cause an even more rapid change in plant communities.

SAVING THE DUNES

SAND DUNE LEGISLATION

Coastal dunes are in danger of being destroyed by overuse, misuse and unwise development. They are popular sites for home building, off-road vehicle use and other intensive recreational uses, as well as sand mining and other commercial activities. Such activities, when allowed to continue in an uncontrolled and improper way, may result in dune destruction. Recognizing this threat, the people of Michigan enacted legislation in 1989 to more adequately ensure protection of the dunes. The two statutes, **Public Acts (PA) 146 and 147 of 1989**, together form the basis for protecting sand dunes from indiscriminate development. The acts, passed unanimously by both the Senate and House of Representatives, focus protective standards on dunes considered to be the most sensitive. Such areas are now legally defined as critical dunes and include approximately 70,000 acres along the shorelines of Lakes Michigan and Superior. Critical dunes are designated by the acts and are identified in the Atlas of Critical Dunes, dated February, 1989, developed by Land and Water Management Division, Department of Natural Resources (DNR).

Passage of these two sand dune statutes came after years of effort by Governor James J. Blanchard, a number of legislators, representatives of local governments, environmental groups, the Natural Resources Commission, and the DNR. Both acts amend the **Sand Dunes Protection and Management Act, PA 222 of 1976**, by expanding regulated uses to include commercial, residential and industrial developments, in addition to the mining industry already regulated by the existing act. The standards in the acts are intended to ensure that the dunes are protected when new uses and developments are proposed that significantly alter the physical characteristics of a critical dune area. The standards, among other things, require new uses to be set back behind the crest of a critical dune, limit the amount of grading and vegetation removal allowed, and prohibit construction on steep slopes.

PUBLICLY OWNED DUNES

Approximately 40 percent of the coastal dunes are in public ownership and managed by federal, state, or local units of government. State-owned lands are managed by DNR/Natural Resources Commission policy guidelines designed to fit the appropriate use with the sensitivity level of each dune area. The DNR will continue to coordinate and cooperate with federal and local units of government to develop consistent management plans for all public sand dune areas.

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SAND DUNE VIEWING AREAS

Listed below are locations where sand dunes can be found and enjoyed in Michigan. Remember that dune habitats are fragile and easily damaged by human activity. Visit these areas in small groups and use boardwalks or special viewing platforms when available.

		FACILITY / ADDRESS	COUNTY/PHONE
Eastern Upper Peninsula	1	Pictured Rocks National Lakeshore Box 40 Munising, MI 49862	Alger County (906) 387-2607
	2	Highway Viewing Eastern Upper Peninsula Hiawatha National Forest 1498 W. 2 St. Ignace, MI 49781	Mackinac County
Northwest Lower Peninsula	3	Wilderness State Park Box 380 Carp Lake, MI 49718	Emmet County (616) 436-5381
	4	Petoskey State Park 2475 - M 119 Petoskey, MI 49770	Emmet County (616) 347-2311
	5	Fisherman's Island State Park P.O. Box 456 Charlevoix, MI 49720	Charlevoix County (616) 547-6641
	6	Sleeping Bear Dunes National Lakeshore P.O. Box 277, 9922 Front Street HWY M-72 Empire, MI 49630	Leelanau County (616) 326-5134
	7	Orchard Beach State Park 2064 Lakeshore Road Manistee, MI 49660	Manistee County (616) 723-7422
	8	Ludington State Park Box 709 Ludington, MI 49431	Mason County (616) 843-8671
	9	Nordhouse Dunes U.S. Forest Service 1658 Manistee Highway Manistee, MI 49660	Manistee County (616) 723-2211

		FACILITY / ADDRESS	COUNTY/PHONE
Southwest Lower Peninsula	10	Mears State Park P.O. Box 370 W. Lowell Street Pentwater, MI 49449	Oceana County (616) 869-2051
	11	Silver Lake State Park Route 1, Box 187 Mears, MI 49436	Oceana County (616) 873-3083
	12	Muskegon State Park 3560 Memorial Drive North Muskegon, MI 49445	Muskegon County (616) 744-3480
	13	P.J. Hoffmaster State Park 6585 Lake Harbor Road Muskegon, MI 49441	Muskegon County (616) 789-3711
	14	Grand Haven State Park 1001 Harbor Avenue Grand Haven, MI 49417	Ottawa County (616) 842-6020
	15	Holland State Park Ottawa Beach Road Holland, MI 49424	Ottawa County (616) 399-9390
	16	Saugatuck State Park c/o Holland State Park Ottawa Beach Road Holland, MI 49424	Allegan County (616) 399-9390
	17	Van Buren State Park 23960 Ruggles Road South Haven, MI 49090	Van Buren County (616) 637-2788
	18	Warren Dunes State Park Sawyer, MI 49125	Berrien County (616) 426-4013
	19	Grand Mere State Park Stevensville, MI 49727	Berrien County (616) 426-4013
Eastern Lower Peninsula	20	Albert E. Sleeper State Park 6573 State Park Road Caseville, MI 48725	Huron County (517) 856-4411
	21	Lakeport State Park 7605 Lakeshore Road, Route 1 Port Huron, MI 48060	St. Clair County (313) 327-6765

LOCATION OF MICHIGAN COASTAL DUNES

Numbers on map refer to sand dune viewing area list.
Dark lines refer to coastal sand areas.

For more information, visit:

The GILLETTE NATURE CENTER, Michigan Department of Natural Resources, sand dune interpretive center. Located in P. J. Hoffmaster State Park, Muskegon, the center features multi-image presentations, exhibit hall, classroom, galleries and hiking trails and boardwalks into the surrounding dunes of the Park. Call 616-798-3573 for information.

COMPLIMENTS OF:

MICHIGAN'S WILDLIFE NEED YOUR HELP

Look for the Loon

Look for the Loon on your state tax form and give to the Nongame Wildlife Fund

The Nongame Wildlife Fund is:

- Ensuring the Loon will always be a part of our north country.
- Bringing the majestic Peregrine Falcon back to Michigan.
- Protecting and restoring the Bald Eagle, Piping Plover, Calypso orchid and other endangered species.
- Helping you enjoy the rich wildlife heritage we share by providing informational brochures, teaching materials for schools and wildlife viewing platforms and trails.

Contributions to the Nongame Wildlife Fund on the state tax form are the **primary support** for management of non-hunted wildlife and endangered plants and animals in Michigan.

You can make a direct contribution to the Fund with a check made payable to "Nongame Wildlife Fund." Mail to Nongame Wildlife Fund, Box 30180, Dept. D., Lansing, MI 48909.

To get a free 22″ x 32″ Wildlife Poster, send your name and address to: Poster, Nongame Wildlife Fund, Box 30028, Dept. D., Lansing, MI 48909.

DNR

NATURAL HERITAGE PROGRAM

This poster was produced with the cooperation of the Nongame Wildlife Citizen's Advisory Committee and the DNR Executive, Geological Survey, Land and Water Management, Parks, and Wildlife Divisions and Office of Public Information.

DESCRIPTIONS OF DUNE PLANTS AND ANIMALS

INVERTEBRATES

Monarch Butterfly *(Danaus plexippus)*

Often called the Milkweed Butterfly, this large black-veined orange-winged butterfly can be observed feeding on milkweed. During its mating behavior, the adult male monarch will display a "courtship dance." Perching on the tips of the milkweed, it will fly to other large butterflies to see if one is a female monarch; if it is, they will fly together in a fast, darting flight, lasting up to a minute and covering many yards and to a height of 100 feet. As fall approaches, the monarchs can be seen in large numbers migrating along the Great Lakes shorlines enroute to Mexico and Central America.

Lake Huron Locust
(Trimerotropis huroniana)

Open, sparsely vegetated northern Michigan dunes is home to this silver-gray locust with the pale yellow hindwings. A lack of suitable undisturbed habitat has resulted in listing this species on the Special Concern list in Michigan.

VERTEBRATES

REPTILE

Eastern Hognose Snake
(Heterodon platyrhinos)

Sometimes called a puff adder, the hognose snake is thick-bodied, slow-moving, and harmless to humans. This species was named for its flattened, upturned "nose", which it uses as a shovel while burrowing into the soil in search of food. Rarely more than three feet long, hognose snakes come in a variety of colors—usually gray, brown, yellow or olive—and may be solid colored or patterned with dark spots and blotches on a lighter background. They are typical inhabitants of the wooded dunes of western Michigan.

BIRDS

Broad-winged Hawk *(Buteo platypterus)*

Broad-winged hawks are solitary forest birds except during their migration period, when large numbers are often seen flying together. When conditions are favorable, hundreds of birds may form huge flocks, called kettles. In this formation, the birds circle together to the tops of warm air thermals and then glide to another with minimal effort. In using the thermals the birds expend less energy during their long flight to and from South America where they spend their winters.

Piping Plover *(Charadrius melodus)*

Piping plovers look like a small, pale killdeer with a single dark breast stripe. Their preferred habitat is a wide, sandy beach along the Great Lakes shore in areas that have scant vegetation and scattered stones. Their nesting territories often include a small stream or interdunal wetland. Piping plovers lay four eggs in a small scrape on the ground and depend on the coloration of their eggs and feathers for protection. Piping plovers are an endangered species in Michigan. There are only about 15 pairs on the entire Great Lakes shoreline, all of which nest in Michigan. They winter on the Atlantic and Gulf of Mexico coasts.

American Goldfinch *(Carduelis tristis)*

The American goldfinch male is well known, with its bright yellow body contrasting with black wings and a black cap. It is one of the common songbirds found in dunes. They are one of the latest nesting birds, typically nesting in July and August. Goldfinches feed primarily on seeds but feed insects to their young. They will often be seen feeding on newly ripened thistle heads, or in winter may be seen feeding on seeds in weedy areas. The goldfinch is one of the most common birds at winter feeding stations in Michigan.

MAMMALS

White-tailed Deer *(Odocoilus virginianus)*

The white-tailed deer is one of Michigan's most popular and successful animals. Noted for its beauty, grace, keen senses and wariness, it is found in every Michigan county. Unlike many of our native species the white-tail has flourished because of its ability to adapt to disturbed areas, alteration of forest habitat, and our hodgepodge of land use practices. Dunes are not usually thought of as deer habitat, yet the white-tail is a common summer resident, and its tell-tale tracks are a prevalent feature of open dunes.

Red Fox *(Vulpes vulpes fulva)*

Although common in coastal dunes, the red fox is found in a wide variety of habitats throughout the state. This bright-colored canid is seldom seen due to its largely nocturnal nature. Its tracks and scat are evidence of its presence. This popular furbearer is much smaller than most people believe. A large fox will stand 14 inches high and weigh only 12-15 pounds. It can easily pass through a four-inch hole. The red fox has been described as an everything eater. Its diet is very diverse, from berries and insects to frogs, small mammals and birds. Its mainstay is small mammals such as the meadow vole and white-footed mouse. The fox's barking call is often heard at night.

Man *(Homo sapiens)*

Can you find the man in the poster?

PLANTS

Sand Cherry *(Prunus pumila)*

A familiar low shrub of coastal dunes, this creeping plant can be found along most of Michigan's shores and in several other habitats throughout the state. It occurs throughout open dune areas and typically colonizes foredunes, serving as an important sand stabilizer. The plump, roundish cherries, which are substantially larger than those produced by black cherry, choke cherry or pin cherry, are mature when they turn a deep blackish-purple. The fruits are edible and a favorite wildlife food, sweet but somewhat astringent tasting, and usually much more suitable for making jellies and jams than eating directly from the bush.

Beach Grass, Marram Grass
(Ammophila breviligulata)

Beach grass is clearly one of the most critically important dune plants. Its fast-growing rhizomes can respond to the constantly shifting sands, enabling this species to serve as a significant sand-binder. Sand reed grass, *Calamovilfa longifolia*, is also a common grass of the dunes, bearing tough rhizomes that allow it to perform a similar ecological role. The latter species, which is usually a much taller plant than beach grass, can also be distinguished by its more open seed heads.

Pitcher's Thistle *(Cirsium pitcheri)*

This rare and easily recognized thistle occurs primarily within the state of Michigan. It is protected by state and federal endangered species laws as a threatened plant, and is known globally only from open dunes along the shores of Lakes Michigan, Huron, and Superior. The stems and deeply divided, spine-tipped leaves are distinctly bluish-green covered with dense, white-woolly hairs. The flowers are cream-colored, sometimes becoming slightly pinkish, and have a faint pleasant scent.

Lake Huron Tansy
(Tanacetum huronense)

Lake Huron tansy is a threatened plant of the coastal dunes, occurring on the northern shores of Lakes Michigan and Huron and the Lake Superior shoreline. This large-headed tansy, which also occurs in northeastern North America, has lacy, hairy leaves and bright yellow, virtually ray-less flower heads that emerge in mid- to late-summer. Like the common garden tansy, which can be distinguished by its much smaller flower heads and non-hairy leaves, all parts of the plant have a very characteristic pungent odor when crushed.

Houghton's Goldenrod
(Solidago houghtonii)

This threatened plant is protected by both federal and state endangered species laws. Its global range is almost entirely restricted to Michigan, where it occurs in interdunal wetlands along the northern shores of Lakes Huron and Michigan, primarily in the Mackinac Straits region. A rather slender-leaved goldenrod, it produces relatively large flower heads.

Sea-rocket *(Cakile edentula)*

Although sea-rocket can sometimes be found at some distance from the water's edge, even on perched dunes, it most often occurs on the beach strand where its seeds are typically deposited. This unusual member of the mustard family occurs in Michigan primarily on the shores of Lakes Huron and Michigan. At maturity, the fruits break into segments that become dispersed in the water, producing new plants when the seeds are washed ashore on some distant strand.

Beach Pea *(Lathyrus japonicus)*

This somewhat low, sprawling plant, which ranges around the world on marine coasts and inland shores, is a native legume found along much of Michigan's shoreline. Beach pea can be recognized by its alternate leaves that are divided into several segments and the clusters of purple to blue pea-like blossoms.

Hairy Puccoon
(Lithospermum caroliniense)

When in bloom, this member of the borage family can be readily spotted on the open sand dunes by its clusters of bright yellow-orange, tubular flowers. This species is characteristic of the dunes but also occurs inland in dry sandy oak barrens and other upland prairie-like sites. A very similar species, Hoary puccoon, *Lithospermum canescens*, is found in open woods and prairies.

Harebell *(Campanula rotundifolia)*

Commonly occurring on many of Michigan's dunes, though not restricted to them, the harebell flowers through much of the summer, creating bright splashes of blue on the dunes and beach landscape. Often growing in clumps, the perennial, narrow-leaved plants have milky sap, an aid to identification. The blue flowers are slightly nodding and bell-shaped with short lobes.

Creeping Juniper *(Juniperus horizontalis)*

As suggested by the scientific name, this evergreen is a low, trailing plant. It occurs in a variety of habitats in northern lower Michigan and the Upper Peninsula. It thrives on the open dunes, particularly in areas with an alkaline (basic) substrate. Its needle-like foliage is very similar to that of our common red cedar. The cones are berry-like and eaten and dispersed by birds.

Sand-dune Willow *(Salix cordata)*; **Sandbar Willow** *(S. exigua)*, and **Blueleaf Willow** *(S. myricoides)*

Although many willows are plants of wet places, several grow on coastal dunes. Despite the difficulty often encountered in identifying willows, the sand dune willow can be easily identified by its relatively broad leaves that are slightly heart-shaped at the base and usually covered with dense, silky hairs. The wide-ranging sandbar willow, a common species of the dunes, can be recognized by its very narrow long leaves that have widely spaced teeth. Finally, the blueleaf willow, a shrubby species like the preceding, can also be expected along Michigan's sandy shores and dunes.

Wormwood *(Artemisia campestris)* and **Clustered Broom-rape**
(Orobanche fasciculata)

A widespread species of sandy soils, wormwood is also a very characteristic plant of Michigan's dunes. The foliage has the typical silvery, blue-green aspect of many other sand dune species. In upper Lake Michigan, especially on perched dunes you may find the rare fascicled broom-rape. It is a threatened species. This parasitic plant, which is also distributed in the prairies of the Great Plains, does not produce chlorophyll, and in Michigan always occurs in association with wormwood, its only known host here.

Bearberry, Kinnikinick
Arctostaphylos uva-ursi)

This low evergreen shrub occurs in several habitats throughout Michigan, including the dunes of all of our shores. The trailing stems have a papery, shreddy bark, and bear oval, dark green, leathery leaves about one inch long. The tiny bell-shaped flowers, which are often white with pinkish tips, arise in terminal clusters, producing dull reddish berries that, although edible, are rather tasteless.

Milkweed *(Asclepias syriaca)*

One of several milkweeds occurring in Michigan, this milkweed species is our most common. The dense round clusters of dull purple flowers have an extremely sweet fragrance and produce abundant nectar, attracting a wide variety of pollinators, among them the large and striking monarch butterfly. Milkweed plays a critical role in the life cycle of the monarch, serving as the preferred host plant for its conspicuously black and yellow-striped larvae and for the green chrysalis rimmed with gold dots attached to the bottom of a leaf. Because of the abundance of milkweed on Michigan's coastal dunes, the dunes form an important migration pathway for this beautiful butterfly.